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Measurements of Ionospheric Properties during Geomagnetic Storms

Radio communication systems are critical to daily life in the modern world, so much so that it is often taken for granted. For example, most pilots use GPS to navigate the skies, and banks use the ionosphere to conduct card transactions. The ionosphere is a layer of the atmosphere that is filled with plasma, and lies roughly 80 to 600 kilometers above Earth's surface. It is possible to sort the ionosphere into layers, like the F2 layer which primarily reflects radio waves. Most of the technological world that exists now cannot exist without radio waves. The ionosphere plays a key role in radio communication systems due to its ability to reflect and modify radio waves. Thus variations in the ionosphere are closely studied to ensure that many systems stay active and functional. When the Sun emits a large amount of electrons towards Earth, the resulting shock to the Earth's magnetic field generates geomagnetic storms, and this causes intense variations in the ionosphere.

To better understand and track the effects of geomagnetic storms on the ionosphere, we studied the geomagnetic storm on May 11th, 2024, due to its intensity. We hypothesized that the drift velocity, total electron content (TEC), and the F2 peak heights would be affected. Using the GIRO database, SAOExplorer, DriftExplorer, and MATLAB, we compiled the drift velocities, F2 peak heights, and the TEC at varying latitudes for the month of May in both 2023 and 2024. We compared these two sets of values treating the 2023 dataset as a control.

We found that during the 2024 May 11th storm the F2 peak heights and the velocities were both much greater than in May 2023, however, the TEC remained relatively stable during this time. The stability of the TEC is of particular interest, since the TEC should have experienced some variation according to current research. Moving forward we plan to further understand and relate the effects of geomagnetic storms on the ionosphere, as well as discovering the reason behind the stability of the TEC.